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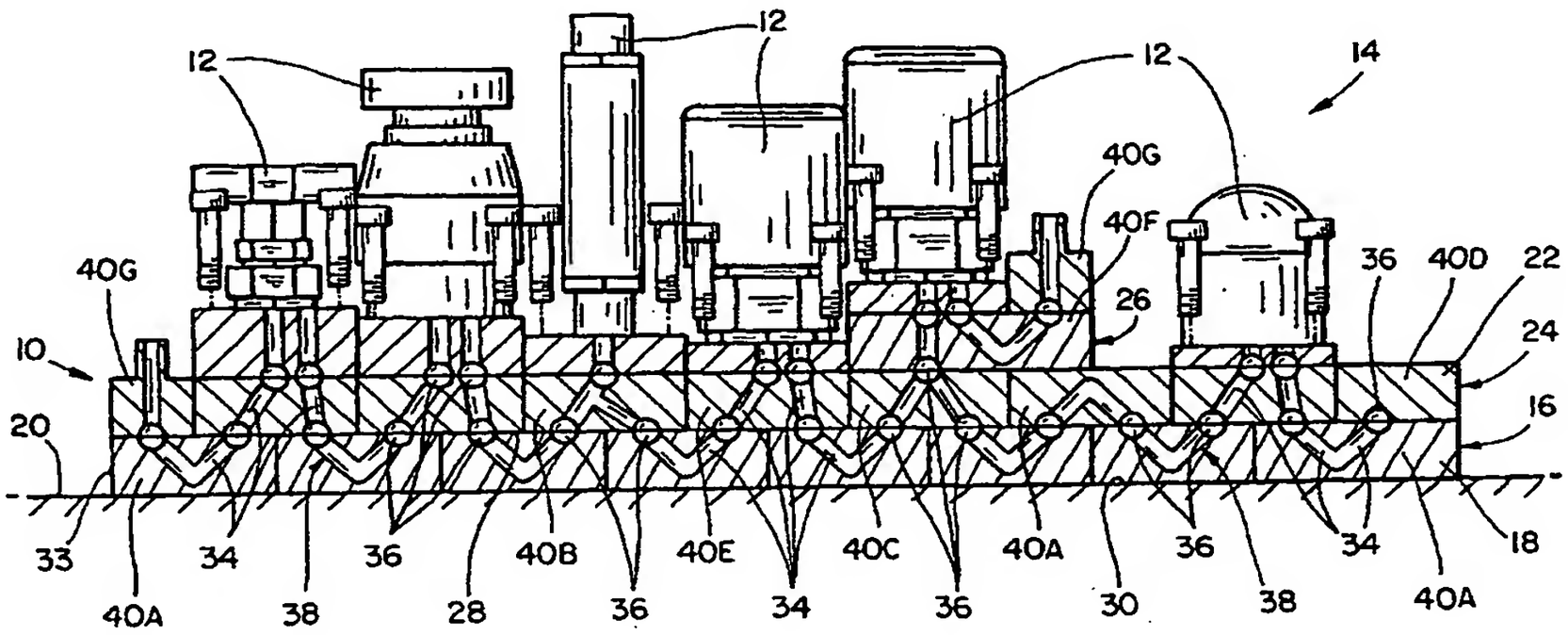
(54) Title: LAYERED BLOCK FLUID DELIVERY SYSTEM



(57) Abstract: A kit for fluid transport includes an upper module (22) coupled to a fluid handling component (12) and lower module (18) coupled with the upper module.

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LAYERED BLOCK FLUID DELIVERY SYSTEM

FIELD OF THE INVENTION

The present invention relates to systems for delivery of a fluid to a tool and more specifically to modular systems for delivery of a fluid to tool.

BACKGROUND OF THE INVENTION

Systems for delivery of a fluid to a tool have a variety of different applications. For instance, the chemical vapor deposition technique used in certain semi-conductor manufacture processes requires that a fluid be delivered to an RTP reactor. The fluid must be delivered to the RTP reactor under very specific conditions. These specific fluid conditions are achieved with the use of a fluid delivery system which transports the fluid to a number of fluid handling components before delivering the fluid to the RTP reactor. These fluid handling components typically measure or adjust the characteristics of the fluid within the fluid delivery system.

The typical fluid delivery systems is frequently modified and updated. Many of these modifications require that the fluid delivery system be disassembled and reassembled in a different configuration. As a result, fluid delivery systems must be highly adaptable.

Fluid delivery systems have been modularized in an attempt to increase their adaptability. Modular fluid delivery systems typically include a plurality independent modules which can be coupled with one another and with fluid handling components. The modules and fluid handling components each include one or more passageways which are aligned with one another upon assembling the fluid delivery system. Alignment of the passageways forms an extended channel through the fluid delivery system. The extended channel serves to transport fluids to the fluid handling components before the fluid is delivered to the tool.

Many modular fluid delivery systems require a large variety of modules in order to retain their adaptability. The large number of modules are often associated with an increased complexity in maintaining the fluid delivery system. Further, a large number of modules can be associated with increased storage costs since spare modules must frequently be stored in order to properly maintain the fluid delivery systems.

Another challenge associated with modular fluid delivery systems is prevention of fluid leaks between adjacent modules or between a module and a fluid handling component. The leaks are prevented by formation of a seal between the adjacent modules and/or between a module and an adjacent fluid handling components. These seals are known to break down over time. Modules within the fluid delivery system must often be temporarily removed or even replaced in order to re-form the seal.

Prior modular delivery systems have presented considerable challenges when a module must be removed or replaced. For instance, many modular fluid delivery systems require that a large portion of the modules be removed before a single module can be replaced and/or that the entire fluid delivery system be disassembled before a single module can be removed. As a result, simple changes in these modular fluid delivery systems can be very time consuming and accordingly, very expensive. Additionally, the number of modules which must be moved and the extended time required to make these modifications can result in contamination of the fluid delivery system.

For the above reasons, there is currently a need for a modular fluid delivery system which permits the modules to be easily accessed, removed and/or changed. There is also a need for a modular delivery system with a reduced opportunity for systemic contamination. Additionally, there is a need for a modular delivery system which retains adaptability with fewer modules.

SUMMARY OF THE INVENTION

The invention relates to a kit for transport of a fluid to a tool. The kit includes an upper module having two or more upper passageways. The upper module is configured to be coupled with a fluid handling component so at least one of the two or more upper passageways is in fluid communication with the fluid handling component. The kit also includes two or more lower modules which each have at least one lower passageway. The two or more lower modules are configured to be concurrently coupled with the upper module such that a lower passageway from each lower module is in fluid communication with a different upper passageway from the upper module.

Another embodiment of the kit includes two or more upper modules which each have two or more upper passageways. Each upper module is configured to be coupled with a different fluid handling component such that at lest one of the two or more upper passageways from each upper module is in fluid communication with one of the fluid handling components. A lower module has a lower passageway and is configured to be concurrently coupled with each of the two or more upper modules such that one of the passageways of one upper module is in fluid communication with one of the passageways of the other upper module through the lower passageway of the lower module.

The invention also relates to a kit for delivery of a fluid to two fluid handling components. The kit includes two or more upper modules which each have two or more upper passageways. Each upper module is configured to be coupled with a different one of the two fluid handling components such that at least one of the two or more upper passageways of each upper module is in fluid communication with the fluid handling component. The kit also includes a lower module having a lower passageway. The lower module is configured to be concurrently coupled with each of the two or more upper modules such that one of the passageways of one upper module is in fluid communication with one of the passageways from the other upper module through the lower passageway of the lower module.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a sideview of a fluid delivery system according to the present invention.

Figure 2 is a cross section of fluid delivery system according to the present invention.

Figure 3 is a cross section of a fluid delivery system including a lateral delivery module coupled with a nozzle module.

Figure 4 illustrates a cross section of a fluid delivery system having a bent shape.

Figure 5A illustrates a bending module incorporated into a fluid delivery system.

Figure 5B is a cross section of the fluid delivery system illustrated in Figure

5A.

Figure 6A illustrates another embodiment of a bending module incorporated into a fluid delivery system.

Figure 6B is a cross section of the fluid delivery system illustrated in Figure 6A.

Figure 7A illustrates a branch module according to the present invention.

Figure 7B illustrates the branch module of Figure 7A incorporated into a fluid delivery system.

Figure 7C illustrates a cross section of the fluid delivery system of Figure 7B.

Figure 8 illustrates a branch module configured to be used to create an X-shaped fluid delivery system.

Figure 9A illustrates a method for coupling the modules of a fluid delivery system to one another.

Figure 9B illustrates a top side of an upper module illustrated in Figure 9A.

DETAILED DESCRIPTION

The present invention relates to an apparatus, a kit and a method for transport of a fluid to a tool. The kit includes a plurality of lower modules which form a base layer on a surface. The kit also includes a plurality of upper modules which can be coupled with the lower modules to form one or more intermediate layers over the base layer. At least a portion of the upper modules can be coupled with a fluid handling component such as a mixing valve. The upper modules, the lower modules and the fluid handling components can be coupled together to assemble a fluid delivery system.

The upper modules, the lower modules and the fluid handling components include passageways which can be aligned with one another upon assembling the system. The alignment of these passageways creates one or more extended channels through the lower layer, the one or more intermediate layers and the fluid handling components. During operation of the fluid delivery system, a fluid is passed through the extended channel to each of the fluid handling components before being

delivered to a tool.

The passageways within the upper and lower modules terminate in fluid ports positioned at the horizontal sides of the modules, specifically at the top side and/or on the bottom sides of the modules. The positioning of the fluid ports at the upper and bottom sides prevents the need for fluid ports at the lateral sides of the modules. As a result, the lateral sides of adjacent upper modules and/or the lateral sides of the adjacent lower modules need not be in physical contact with one another although they can be. Because adjacent modules need not be in contact with one another, a module can be removed from the base layer or from one of the intermediate layers without removing adjacent modules from the same layer.

To provide fluid communication between two lower modules which are adjacent to one another in a layer, an upper module can straddle the two lower modules. Passageways within the two lower modules can be in fluid communication with one another via a passageway in the upper module.

One upper module straddling two or more lower modules permits easy change and repair of a fluid delivery system formed from these modules. For instance, when an upper module in an intermediate layer needs to be replaced or removed, the upper module can be easily accessed by removing only the fluid handling component to which the upper module is coupled. As described above, this upper module can then be removed from the intermediate layer without disturbing the adjacent upper modules. Additionally, when a lower module needs to be replaced or removed, the lower module can normally be accessed by removing the two upper modules to which the lower module is coupled. The lower module can then be removed from the base layer without disturbing the adjacent lower modules. As a result, the present invention provides a kit for assembling a fluid delivery system which is easily modified.

The ability to easily modify the fluid delivery system also reduces the opportunities for systemic contamination. Specifically, a fluid delivery system according to the present invention can be quickly repaired or modified. The reduced time for modification reduces the time frame within which systemic contamination can occur. Additionally, modification of a fluid delivery system according to the present invention frequently involves a reduced number of modules. Reducing the

number of modules involved in a modification reduces the number of contamination sources and accordingly the overall opportunity for contamination.

Figure 1 illustrates a fluid delivery apparatus 10 coupled with fluid handling components 12 to form a fluid delivery system 14. The fluid delivery apparatus 10 includes a base layer 16 comprised of a plurality of lower modules 18. The lower modules 18 can be positioned adjacent to a flat surface 20 and can optionally be affirmatively coupled with the flat surface 20 to stabilize the base layer 16 relative to the flat surface 20. Example flat surfaces 20 include, but are not limited to, tabletops and the sides of machinery such as the machinery used in semiconductor manufacture.

The lower modules 18 of the base layer 16 are adjacent to upper modules 22 which form a first intermediate layer 24. The upper modules 22 can optionally be affirmatively coupled with the lower modules 18 to keep the first intermediate layer 24 in position relative to the base layer 16. The upper modules 22 in the first intermediate layer 24 are adjacent to upper modules 22 forming a second intermediate layer 26. The upper modules 22 in the second intermediate layer 26 can optionally be affirmatively coupled with the upper modules 22 in the second intermediate layer 26 to keep the second intermediate layer 26 in position relative to the first intermediate layer 24. Although not illustrated, the fluid delivery apparatus 10 can include additional intermediate layers.

Upper modules 22 from the first intermediate layer 24 and the second intermediate layer 26 are coupled with fluid handling components 12. Suitable fluid handling components 12 include, but are not limited to, nozzles, inlet ports, outlet ports, pressure gauges, pressure regulators, pressure transducers, filters, purifiers, mixing valves, pneumatic valves, manually operated valves, check valves, flow meters and mass flow controllers, as well as other control and metering components. In operation, the fluid delivery apparatus 10 transports the fluids required for operation of the fluid handling components 12 to and/or from the fluid handling components 12.

The lower modules 18 and the upper modules 22 can have a block shape in order to provide the apparatus with stability relative to the flat surface 20. The block shape consists of a top side 28 and a bottom side 30. The bottom side 30 of the

lower module 18 preferably has a flat portion 32 which permits the lower module 18 to be positioned flush against the flat surface 20. Similarly, the bottom side 30 of the upper modules 22 preferably has a flat portion 32 configured to be positioned adjacent to a flat portion 32 on the top side 28 of the lower modules 18. Additionally, the top side 28 of the upper modules 22 preferably has a flat portion 32 configured to be positioned adjacent to a flat portion 32 on the bottom side 30 of another upper module. Finally, the top side 28 of the upper modules 22 preferably has a flat portion 32 which is configured to be positioned adjacent to a flat portion 32 on a base of a fluid handling component 12.

Although the top side 28 and the bottom side 30 of the upper and lower modules 18 preferably have flat portions 32, they can optionally have shape, contour and/or texture. For instance, the top side 28 of the lower modules 18 can have a contour which is complementary to the bottom side 30 of the upper modules 22. The contour can be interlocking to provide an affirmative grip between adjacent lower and upper modules 22.

Block shaped modules can also have one or more lateral sides 33. For instance, the modules can have one lateral side 33 in the case of cylindrically shaped modules or four lateral sides 33 in the preferred case of a square shaped module. The lateral sides 33 preferably have flat portions 32 which allow the modules to be positioned adjacent to one another in a layer. However, the lateral sides 33 can have shape, contour and/or texture. For instance, the lateral sides 33 can have a contour which permits adjacent modules in a layer to be interlocked with one another.

Figure 2 provides a cross sectional view of the fluid delivery system 14. The upper and lower modules 18 include at least one passageway 34 terminating in at least one fluid port 36 positioned at a top side 28 and/or a bottom side 30 of the upper and lower modules 18. Each upper modules 22 is coupled with two lower modules 18 such that a fluid port 36 from each of the two lower modules 18 is aligned with a different fluid port 36 from the upper module. The alignment of these fluid ports 36 provides fluid communication between each upper module and the associated lower modules 18.

Each fluid handling component 12 includes one or more fluid ports 36 aligned with fluid ports 36 at the top side 28 of an upper module. This alignment

permits fluid communication between the fluid handling component 12 and at least one passageway 34 of the upper module. The coupling of the lower modules 18, the upper modules 22 and the fluid handling components 12 creates an extended channel 38 through the fluid delivery apparatus 10 and the fluid handling components 12. A fluid can flow through the extended channel 38 to each of the fluid handling components 12 along the extended channel 38. Suitable fluids for use within the extended channel 38 are flowable materials such as gasses, liquids and/or gas/liquid combinations.

The fluid delivery system 14 can be assembled in various configurations. The number of configurations is increased by the various upper and lower modules 18 which can be used. For instance, a plurality of extension modules 40A are illustrated in Figure 2. The extension modules include a single passageway 34 terminating in two fluid ports 36 at either the top side 28 of the extension module or at the bottom side 30 of the extension module. Extension modules are useful for extending the length of the extended channel 38 and can optionally be designed to be interchangeable for use as an upper module or as a lower module 18. When a series of extension modules are positioned adjacent to one another in a base layer 16, the series of extension modules can be replaced by a single base module which integrates each of the extension modules into a single block.

Figure 2 also illustrates a junction module 40B including three passageways 34 which are coupled with one another within the junction module. One of the passageways 34 terminates in a fluid port 36 at the top side 28 of the junction module 40B and the other two passageways 34 terminate in a fluid port 36 at the bottom side 30 of the junction module 40B. Junction modules are useful for coupling with fluid handling components 12 having a single fluid port 36. Figure 2 also illustrates a second embodiment of a junction module 40C. The junction module 40C includes two passageways 34 which each terminate at a common fluid port 36A at the top side 28 of the junction module 40C. Each passageway 34 also terminates at a different fluid port 36 at the bottom side 30 of the junction module 40C.

A terminal module 40D is also illustrated in Figure 2. The terminal module 40D includes a passageway 34 which is closed at the end. The terminal module can

be used to create an end to the extended channel 38.

Figure 2 illustrates a utility module 40E. The utility module 40E includes two independent passageways 34. Each passageway 34 terminates at a fluid port 36 at the top side 28 of the utility module 40E and in a fluid port 36 at the bottom side 30 of the utility module 40E. As illustrated, a utility module 40E can serve to transport fluid through fluid handling components 12 having two fluid ports 36.

Figure 2 illustrates a second embodiment of a utility module 40F having two independent passageways 34. One of the passageways 34 terminates in a fluid port 36 at the top side 28 of the utility module 40F and terminates in a fluid port 36 at the bottom side 30 of the utility mode 40F. Another of the passageways 34 terminates in two different fluid ports 36 positioned at the top side 28 of the utility module 40F. This type of utility module 40F can be used with fluid handling components 12 requiring a fluid inlet port and fluid outlet port. However, this utility module 40F has the added benefit of transporting fluid to additional fluid handling components 12 or additional modules without returning the fluid to a layer below the utility module 40F. For instance, as illustrated in Figure 2, the fluid is transported to a nozzle module 40G without being transported to the first intermediate layer 24.

The nozzle module 40G includes a passageway 34 terminating at fluid port 36 at a top side 28 of the nozzle module 40G and at a bottom side 30 of the nozzle module 40G. The fluid port 36 at the top side 28 of the nozzle module 40G is configured to be coupled with a fluid conduit such as a hose. The coupling to the fluid conduit can be permanent as in the case of a weld or can be removable as in the case of a quick connect attachment. Fluid from the conduit can be transported into the extended channel 38 of the fluid delivery apparatus 10 through the nozzle module 40G. Similarly, fluid can be transported from the extended channel 38 of the fluid delivery apparatus 10 into the fluid conduit.

Another embodiment of a nozzle module 40H is illustrated in Figure 3. The nozzle module 40H includes a passageway 34 which terminates at a fluid port 36 on a top side 28 of the nozzle module 40H and which terminates at a fluid port 36 at a lateral side 33 of the nozzle module 40H. The nozzle module 40H is illustrated as being coupled with a branched fluid conduit. Each branch of the fluid conduit can be coupled with different equipment. For instance, one branch can be coupled with

a fluid source while the other branch can be coupled with another fluid delivery apparatus 10.

Figure 3 also illustrates a lateral side 33 of a lateral delivery module 40I. The lateral delivery module 40I includes a passageway 34 which terminates in a fluid port 36 at a top side 28 of the lateral delivery module 40I and which terminates in a fluid port 36 at a bottom side 30 of the lateral delivery module 40I. The lateral delivery module 40I also includes another passageway 34 which terminates in a fluid port 36 on a top side 28 of the lateral delivery module and which terminates in a fluid port 36 in a lateral side 33 of the lateral delivery module 40I. The lateral side 33 of the lateral delivery module 40I is coupled with the lateral side 33 the nozzle module 40H such that a passageway 34 of the lateral delivery module is in fluid communication with the passageway 34 of the nozzle module. As a result, lateral delivery modules 40I permits fluid communication through a lateral side 33 of a module.

The fluid delivery systems 14 can include other embodiments of the lateral delivery module. For instance, one embodiment includes a single passageway 34 terminating in a fluid port 36 at the lateral side 33 of the lateral delivery module. Another embodiment can include a passageway 34 terminating in fluid ports 36 positioned at different lateral sides 33 of the lateral delivery module or in fluid ports 36 positioned at the same lateral sides 33 of the lateral delivery device.

Figure 4 provides a cross section of an L-shaped fluid delivery apparatus 10 having a bend module 40J. Providing a bend in the fluid delivery apparatus 10 can reduce the space required by the fluid delivery apparatus 10. The bending module 40J includes a passageway 34 which terminates in two fluid ports 36 at the top side 28 of the bending module. The bending module 40J has an extended length which is labeled L. When the modules have an essentially square shape, the bending module 40J can have a length of approximately one and one half times the length or width of the square modules.

Figure 4 also illustrates a transition module 40K coupled with the bending module 40J. The transition module 40K includes a passageway 34 which terminates in a fluid port 36 at the top side 28 of the transition module 40K and which terminates in a fluid port 36 at the bottom side 30 of the transition module 40K. As

illustrated, the transition module 40K is configured to be coupled with an extension module which is turned at an angle relative to the length of the bending module 40J.

A spacer module 40L is also illustrated in Figure 4. The spacer module 40L does not include a passageway 34 coupled with the extended channel 38 but serves as a spacer. For instance, the spacer modules 40L illustrated in Figure 4 serve to support the first intermediate layer 24 and the second intermediate layer 26.

Figure 5A illustrates two bending modules 40J coupled with one another to provide a bend in the fluid delivery apparatus 10. Figure 5B provides a cross section of a portion of the fluid delivery apparatus 10 illustrated in Figure 5A. The two bending modules 40J form a portion of the extended channel 38 which alters the direction of the fluid flow through the channel 38 by ninety degrees. The arrangement of bending modules illustrated in Figure 5B eliminates the need for the transition module 40K.

Figure 6A illustrates a branch module 40M which can be used to create a T-shaped fluid delivery apparatus 10. Each branch of the T-shaped fluid delivery apparatus 10 can be coupled with different fluid handling components 12 to provide the fluids within each branch with different characteristics. Accordingly, fluid within different extended channels 38 can be delivered to different locations or received from different locations.

Figure 6B is a cross section of the fluid delivery apparatus 10 illustrated in Figure 6A looking down the arrow labeled A. The branch module 40M includes two passageways 34 which are each coupled with a common fluid port 36 and are each coupled with an independent fluid port 36. Further, when the modules have an essentially square shape, the branch module preferably has a length of approximately twice the length or width of the square modules.

Figure 7A illustrates another embodiment of a branch module 40N which can be used to create a T-shaped fluid delivery apparatus 10 such as the fluid delivery apparatus 10 illustrated in Figure 7B. The branch module 40N includes three passageways 34 which are coupled with one another within the branch module 40N. Each passageway 34 is also coupled with a different fluid port 36 on the top side 28 of the branch module 40N.

Figure 7C provides a cross section of the fluid delivery apparatus 10

illustrated in Figure 7B looking down the arrow labeled B in Figure 7B. Each fluid port 36 on the branch module 40N is coupled with a different extension module to form three different extended channels 38 in the fluid delivery apparatus 10.

Figure 8 illustrates another embodiment of a branch module 40P which can be used to produce an X-shaped fluid delivery apparatus 10. The branch module 40P includes four passageways 34 coupled with one another within the module. Each passageway 34 is also coupled with a different fluid port 36 at a top side 28 of the branch module 40P. Similar to the branch module 40N illustrated in Figures 7A-7C, each passageway 34 can be coupled with a different extension module to yield four different extended channels 38.

Although the various modules discussed above are illustrated and/or discussed as having a particular orientation relative to the fluid delivery apparatus 10, each module can be included in the fluid delivery apparatus 10 in an inverted position. For instance, the junction modules are illustrated as having a single fluid port 36 in their top side 28, but they can be inverted so the single fluid port 36 is positioned at the bottom side 30 of the junction modules. Additionally, many of the modules can be designed to be interchangeable between either orientation.

Many of the above modules are illustrated and/or described as being positioned in a particular layer of the fluid delivery apparatus 10. However, many of the modules can be positioned in any of the layers of the fluid delivery apparatus 10. For instance, the two bending modules of Figures 5A-5B are illustrated in a base layer 16 and in a first intermediate layer 24 but they can be used in any two adjacent layers such as a first intermediate layer adjacent to a second intermediate layer 26.

As discussed above, the fluid delivery apparatus 10 can be disassembled and can be re-assembled to provide the fluid delivery apparatus 10 with a different configuration or to change the fluid handling components 12 being used with the fluid delivery apparatus 10. Figure 9A illustrates a technique for assembling the fluid delivery apparatus 10 on a flat surface 20. The lower modules 18 are attached to the flat surface 20 with four fasteners 44. Suitable fasteners 44 include, but are not limited to, threaded fasteners 44 such as bolts and screws. For the purposes of this illustration, it will be presumed that the fasteners 44 are threaded. Each fastener 44 is passed through an unthreaded aperture 46 in the lower module 18 and is then

received in a threaded aperture 48 in the flat surface 20 as illustrated by the arrow labeled C. Once a fastener 44 is received in a threaded aperture 48, the fastener 44 can be turned in order to tighten and loosen the lower module 18 on the flat surface 20. The unthreaded apertures 46 are countersunk so the top of the fastener 44 is positioned even with or below the top side 28 of the lower module 18 when the lower module 18 is tightened onto the flat surface 20. This position of the fastener 44 relative to the lower module 18 allows the bottom side 30 of an upper module to be positioned flush against the top side 28 of the lower modules 18.

After the appropriate lower modules 18 are in place on the flat surface 20, each upper module is coupled with lower modules 18 by four fasteners 44. Each fastener 44 is passed through an unthreaded aperture 46 on the upper module and is received in a threaded aperture 48 in a lower module 18 as illustrated by the arrows labeled D. The fastener 44 can be turned in order to tighten the upper module on the lower module 18. Again, the unthreaded apertures 46 are countersunk.

Once the upper modules 22 are in place, the fluid handling components 12 are coupled with the appropriate upper module using four fasteners 44. The fasteners 44 are passed through an unthreaded aperture 46 in the fluid handling component 12 and are then received in a threaded aperture 48 in the upper module as illustrated by the arrow labeled E. The fastener 44 can then be turned to tighten or loose the fluid handling component 12 on the upper module.

A gasket 50 can be positioned between the fluid handling component 12 and the upper module before the fluid handling component 12 is coupled with the upper module. The gasket 50 can be made from a plurality of materials including, but not limited to, a metal such as 316L. The gasket 50 can include two sealing devices 52 such as O-rings. Additionally, the sealing devices 52 can be independent of the gasket 50. Figure 9B illustrates the top side 28 of an upper module. The top side 28 includes a gasket recess 54 positioned adjacent to the fluid ports 36. The gasket recess 54 has a shape for receiving the sealing devices 52.

The sealing devices can be compressed when the fluid handling component 12 is tightener against the upper module. This compression of the sealing devices 52 forms a seal between the fluid port 36 of the fluid handling component 12 and the fluid port 36 of the upper module in order to reduce loss of fluid due to leakage.

Although neither illustrated nor required, another gasket 50 is preferably positioned between the upper modules 22 and the lower modules 18 or between two upper modules 22.

The upper modules 22 do not require threaded apertures 48. For instance, the fluid handling components 12 and the upper modules 22 can include unthreaded apertures 46 which are aligned with one another when the fluid delivery apparatus 10 is assembled. These apertures also align with threaded apertures 48 on the lower modules 18 during assembly. As a result, a single fastener 44 can be passed through the aligned and unthreaded apertures 46 in the fluid handling component 12 and the upper module and into a threaded aperture 48 in a lower module 18 which has already been secured to a flat surface 20. The fastener 44 can then be tightened in the threaded aperture 48 to secure the fluid handling component 12 and upper module in place. As a result, the number of fasteners 44 which must be removed in order to change a fluid handling component 12 and/or an upper module can be reduced while allowing the lower modules 18 to remain in place on the flat surface 20 while the fluid handling components 12 and upper modules 22 are changed. Because the fluid delivery apparatus 10 can be assembled with multiple intermediate layers, a single fluid delivery apparatus 10 can require a number of fasteners 44 having different lengths.

Additionally, the lower modules 18 do not require threaded apertures 48. For instance, the fluid handling components 12, the upper modules 22, and the lower modules 18 can include unthreaded apertures 46 which are aligned with one another when the fluid delivery apparatus 10 is assembled. A fastener 44 is then passed through the aligned unthreaded apertures 46 in the fluid handling component 12, the upper module, the lower module 18 and into a threaded aperture 48 in the flat surface 20.

The discussion with respect to Figure 9A is for illustrative purposes only. For instance, the number of fasteners 44 per module is not limited to four and can be as few as one. Further, the fluid delivery apparatus 10 can be assembled using techniques other than the techniques described above.

Suitable materials for the modules include, but are not limited to, stainless steel such as 316L VIM/VAR. The lower modules 18 typically have a length of

about 1-2 inches, a width of about 1-2 inches and a height of about inch .25-.75 inches. The upper modules 22 typically have a length of about 1-2 inches, a width of about 1-2 inches and a height of about inch .25-.75 inches. However the dimensions of the different modules can vary extensively. For instance, the length of the upper modules 22 can be varied to accommodate fluid handling components 12 which have bases with unusual geometries or fluid ports 36 which are unusually far apart. A suitable width for the passageways 34 includes, but is not limited to, .18 inches. The fluid ports 36 can be a standard C-Seal to be positioned between an upper module and a fluid handling components and a 1/4 inch VCR to be positioned between adjacent fluid handling components.

While the present invention is disclosed by reference to the preferred embodiments and examples detailed above, it is to be understood that these examples are intended in an illustrative rather than limiting sense, as it is contemplated that modifications and combinations will readily occur to those skilled in the art, which modifications and combinations will be within the spirit of the invention and the scope of the appended claims.

CLAIMS

What is claimed is:

1. A kit for transport of a fluid to a tool comprising:

an upper module having two or more upper passageways, the upper module configured to be coupled with a fluid handling component such that at least one of the two or more upper passageways is in fluid communication with the fluid handling component; and

two or more lower modules which each have at least one lower passageway, the two or more lower modules configured to be concurrently coupled with the upper module such that a lower passageway from each lower module is in fluid communication with a different upper passageway from the upper module.

2. The kit of claim 1, wherein the upper module and the two or more lower modules have a generally block shape.

3. The kit of claim 1, wherein a bottom side of the upper module is configured to be positioned adjacent to a top side of the lower module.

4. The kit of claim 2, wherein the bottom side of the upper module includes a flat portion which is configured to be positioned over a flat portion on a top side of the lower modules.

5. The kit of claim 1, wherein a top side of the upper module includes a flat portion which is configured to be positioned under a flat surface on the fluid handling component.

6. The kit of claim 1, wherein at least one module selected from the group consisting of the upper module and the two or more lower modules includes a top side, a bottom side and a plurality of apertures sized to receive a fastener extending from the top side to the bottom side.

7. The kit of claim 5, further comprising:

a plurality of fasteners.

8. The kit of claim 1, wherein at lest one module selected from the group consisting of the upper module and the two or more lower modules includes a top side with at least one threaded aperture extending into the upper module.

9. The kit of claim 1, wherein the lower modules are configured to be coupled with a flat surface.

10. The kit of claim 1, wherein the lower modules includes a bottom side having a flat portion which permits the lower modules to be stably positioned on a flat surface without additional support.

11. The kit of claim 9, wherein the lower modules include lateral sides having flat portions which permits the lower modules to be positioned adjacent to one another so as to form a base layer on the flat surface.

12. The kit of claim 1, wherein at least one module selected from the group consisting of the upper module and the two or more lower modules includes a passageway terminating in a fluid port positioned at a horizontal side of the module, the horizontal size including a gasket recess configured to receive a gasket adjacent to the fluid port.

13. The kit of claim 1, further comprising:

a gasket configured to be positioned between the upper module and the two or more lower modules.

14. The kit of claim 1, further comprising:

a gasket configured to be positioned between the upper module and the fluid handling component.

15. The kit of claim 1, wherein two of the upper passageways terminate in different fluid ports positioned at a bottom side of the upper module and a lower

passageway from each lower module terminates in a fluid port positioned at a top side of each lower module.

16. The kit of claim 14, wherein the fluid ports are positioned such that when the upper module is coupled with the two or more lower modules, one of the fluid ports from each lower module is aligned with one of the fluid ports from the upper module.

17. The kit of claim 1, wherein one of the at least one lower passageways terminates in two fluid ports at a top side of at least one of the lower modules.

18. The kit of claim 1, further comprising:

a nozzle module having a passageway terminating in a fluid port positioned at a bottom side of the nozzle module and in a fluid port at a top side of the module, the fluid port at the top side of the module configured to be coupled with a fluid conduit.

19. The kit of claim 1, further comprising:

a nozzle module having a passageway terminating in a fluid port positioned at a bottom side of the nozzle module and in a fluid port at a lateral side of the module, the fluid port at the top side of the module configured to be coupled with a fluid conduit.

20. The kit of claim 1, wherein the upper module includes three upper passageways which are coupled with one another within the upper module.

21. The kit of claim 1, wherein the upper module includes two upper passageways which each terminate in a common fluid port positioned at a top side of the upper module or at a bottom side of the upper module.

22. The kit of claim 1, wherein the upper module includes two upper passageways which each terminate in a different fluid port at a top side of the upper

module and which each terminate in a different fluid port at a bottom side of the upper module.

23. The kit of claim 1, wherein the upper module includes a first upper passageway terminating in a fluid port at a top side of the upper module and in a fluid port at a bottom side of the upper module, the upper module also including a second upper passageway terminating in two fluid ports at a top side of the upper module.

24. The kit of claim 1, wherein at least one of the lower modules includes three lower passageways which are coupled with one another and which terminate in three fluid ports positioned at a top side of the lower module.

25. The kit of claim 1, wherein at least one of the lower modules includes four lower passageways which are coupled with one another and which terminate in four fluid ports positioned at a top side of the lower module.

26. The kit of claim 1, wherein at least one of the lower modules includes two lower passageways which both terminate in a common fluid port positioned at a top side of the lower module, each of the lower passageways also terminating in a different fluid port positioned at a top side of the lower module.

27. The kit of claim 1, wherein the fluid handling component is selected from the group consisting of a nozzle, inlet port, outlet port, pressure gauge, pressure regulator, pressure transducer, filter, purifier, mixing valve, pneumatic valve, manually operated valve, check valve, flow meter and mass flow controller.

28. A kit for delivery of a fluid to a tool, comprising:

two or more upper modules which each have two or more upper passageways, each upper module configured to be coupled with a different fluid handling components such that at least one of the two or more upper passageways of each upper module is in fluid communication with one of the fluid handling

components; and

a lower module having a lower passageway, the lower module configured to be concurrently coupled with each of the two or more upper modules such that one of the passageways of one upper module is in fluid communication with one of the passageways of the other upper module through the lower passageway of the lower module.

29. The kit of claim 28, wherein the two or more upper modules and the lower module have a generally block shape.

30. The kit of claim 28, wherein each of the upper modules has a bottom side configured to be positioned adjacent to a top side of the lower module.

31. The kit of claim 29, wherein the bottom side of the upper modules includes a flat portion which is configured to be positioned over a flat portion on a top side of the lower module.

32. The kit of claim 28, wherein a top side of each upper module includes a flat portion which is configured to be positioned under a flat surface on the fluid handling component.

33. The kit of claim 28, wherein at least one module selected from the group consisting of the lower module and the two or more upper modules includes a top side, a bottom side and a plurality of apertures sized to receive a fastener extending from the top side to the bottom side.

34. The kit of claim 28, wherein at least one module selected from the group consisting of the upper module and the two or more lower modules includes a top side which has at least one threaded aperture sized to receive a fastener extending into the upper module.

35. The kit of claim 28, wherein the lower module is configured to be coupled

with a flat surface.

36. The kit of claim 28, wherein the lower module includes a bottom side having a flat portion which permits the lower module to be stably positioned on a flat surface without additional support.

37. The kit of claim 35, wherein the upper modules include lateral sides having flat portions which permit the upper modules to be positioned adjacent to one another so as to form an intermediate layer above the lower module.

38. The kit of claim 28, wherein at least one module selected from the group consisting of the lower module and the two or more upper modules includes a passageway terminating in a fluid port positioned at a horizontal side of the module, the horizontal side including a gasket recess configured to receive a gasket adjacent to the fluid port.

39. The kit of claim 28, further comprising:

a gasket configured to be positioned between the upper module and the two or more lower modules.

40. The kit of claim 28, further comprising:

a gasket configured to be positioned between the upper module and the fluid handling component.

41. The kit of claim 28, wherein a passageway from the lower module terminates in two fluid ports on a top side of the lower module and an upper passageway from each upper module terminates in at least one fluid port positioned at a bottom side of each upper module.

42. The kit of claim 41, wherein the fluid ports are positioned such that when the lower module is coupled with the two or more upper modules, one of the fluid ports from each upper module is aligned with one of the fluid ports from the lower

module.

43. The kit of claim 28, wherein the lower passageway terminates in two fluid ports at a top side of the lower module.

44. The kit of claim 28, wherein at least one upper module includes three upper passageways which are coupled with one another within the upper module.

45. The kit of claim 28, wherein at least one upper module includes two upper passageways which each terminate in a common fluid port positioned at a top side of the upper module.

46. The kit of claim 28, wherein at least one upper module includes two upper passageways which each terminate in a different fluid port at a top side of the upper module and which each terminate in a different fluid port at a bottom side of the upper module.

47. The kit of claim 28, wherein at least one upper module includes a first upper passageway terminating in a fluid port at a top side of the upper module and in a fluid port at a bottom side of the upper module, the upper module also including a second upper passageway terminating in two fluid ports at a top side of the upper module.

48. The kit of claim 28, wherein the lower module includes three lower passageways which are coupled with one another and which terminate in three fluid ports positioned at a top side of the lower module.

49. The kit of claim 28, wherein at least one of the lower modules includes four lower passageways which are coupled with one another and which terminate in four fluid ports positioned at a top side of the lower module.

50. A kit for delivery of a fluid to a tool, comprising:

a first upper module having at least one upper passageway;

a second upper module having two or more upper passageways, the second upper module configured to be coupled with a fluid handling component such that at least one of the two or more upper passageways from the second module is in fluid communication with the fluid handling component; and

a lower module having a lower passageway, the lower module configured to be concurrently coupled with the first and second upper modules such that an upper passageway from the first upper module is in fluid communication with an upper passageway from the second upper module through the lower passageway of the lower module.

51. The kit of claim 50, wherein the first upper module is a nozzle module having an upper passageway terminating in a fluid port positioned at a bottom side of the nozzle module and in a fluid port at a top side of the module, the fluid port at the top side of the module configured to be coupled with a fluid conduit.

52. The kit of claim 50, wherein the first upper module is a nozzle module having an upper passageway terminating in a fluid port positioned at a bottom side of the nozzle module and in a fluid port at a lateral side of the module, the fluid port at the top side of the module configured to be coupled with a fluid conduit.

53. The kit of claim 50, wherein the first upper module includes three upper passageways which are coupled with one another and which terminate in three fluid ports positioned at a bottom side of the first upper module.

54. The kit of claim 50, wherein the first upper module includes four upper passageways which are coupled with one another and which terminate in four fluid ports positioned at a bottom side of the first upper module.

55. The kit of claim 50, wherein at least one of the first upper modules includes two upper passageways which both terminate in a common fluid port positioned at a bottom side of the first upper module, each of the upper passageways also

terminating in a different fluid port positioned at the bottom side of the lower module.

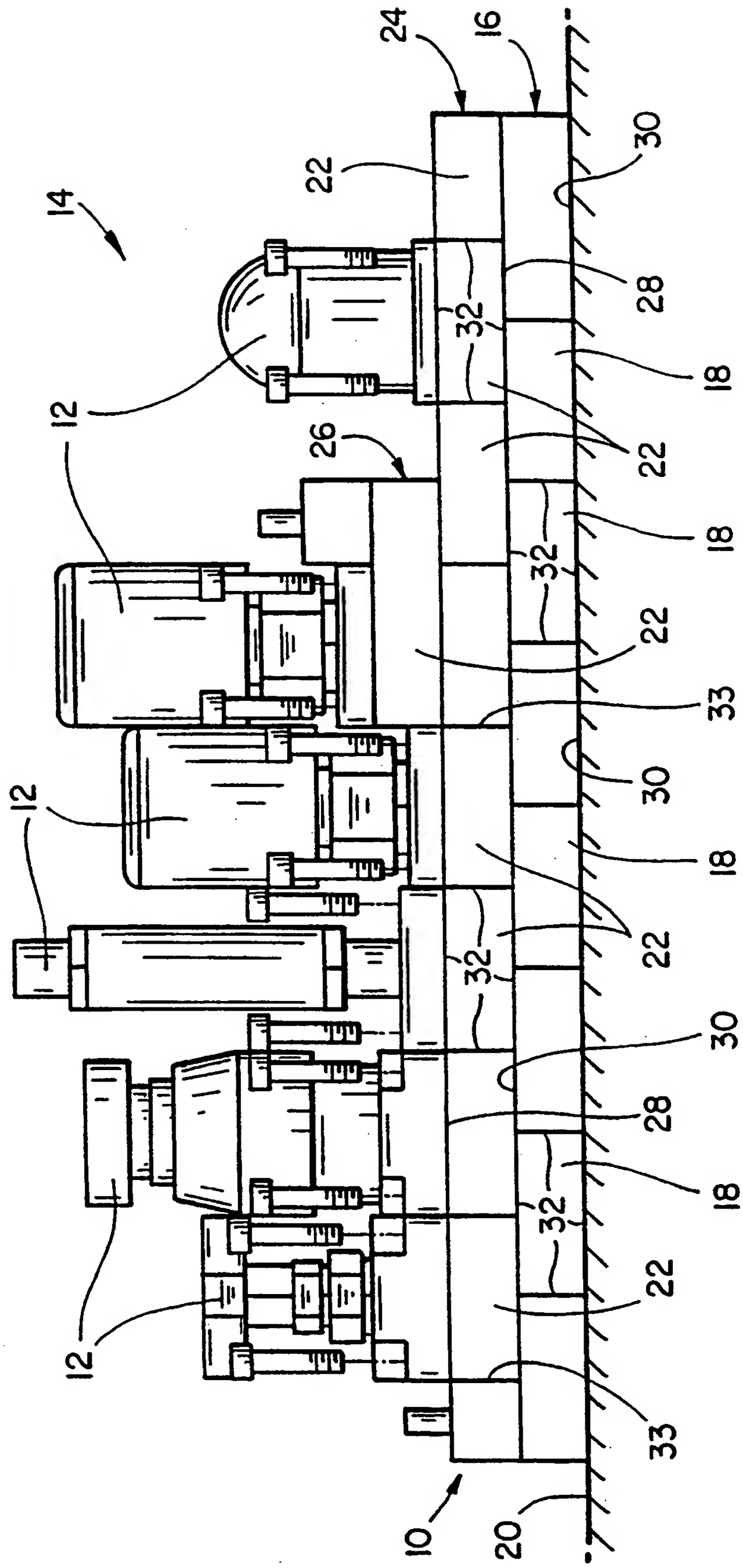


FIG_1

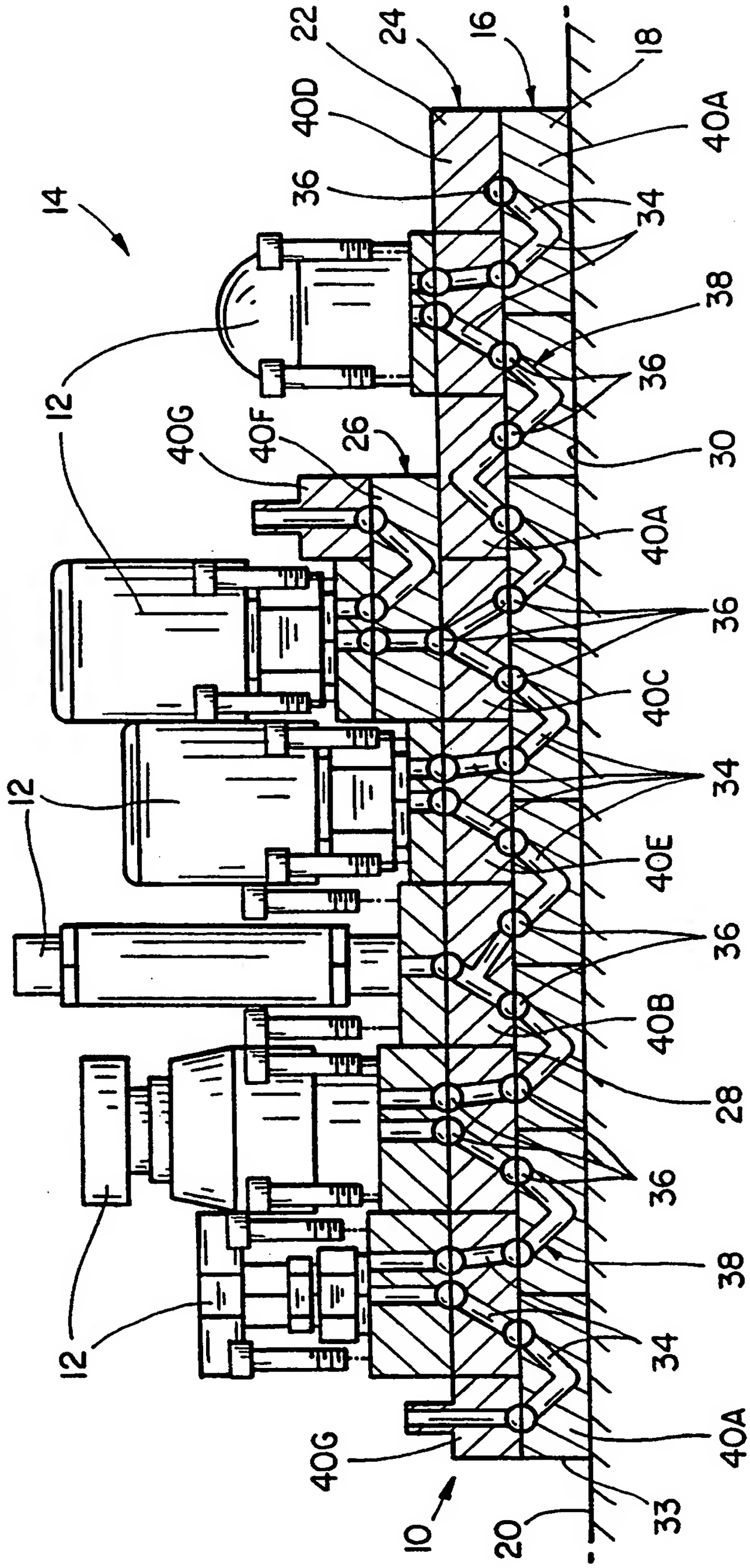


FIG_2

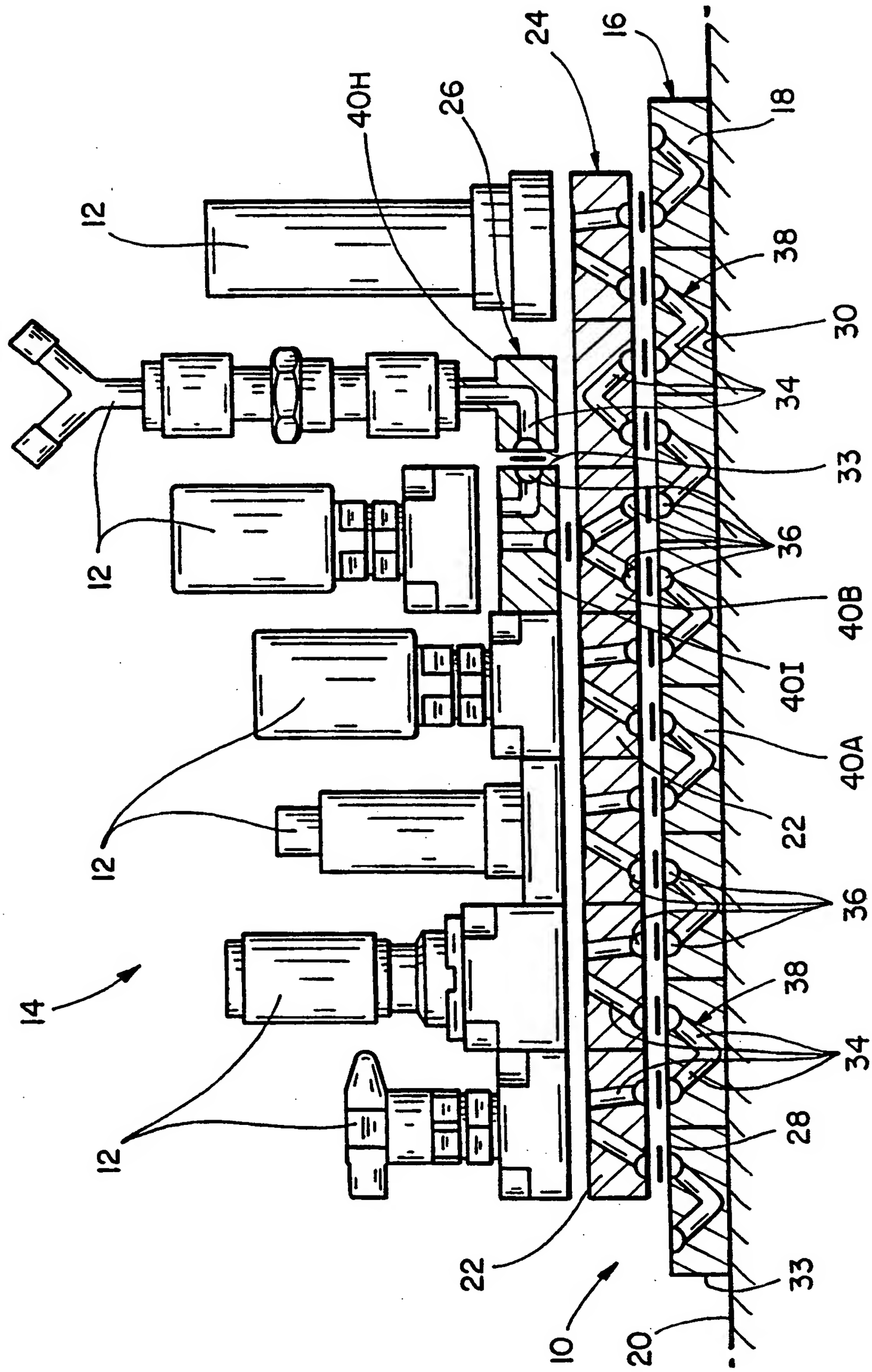
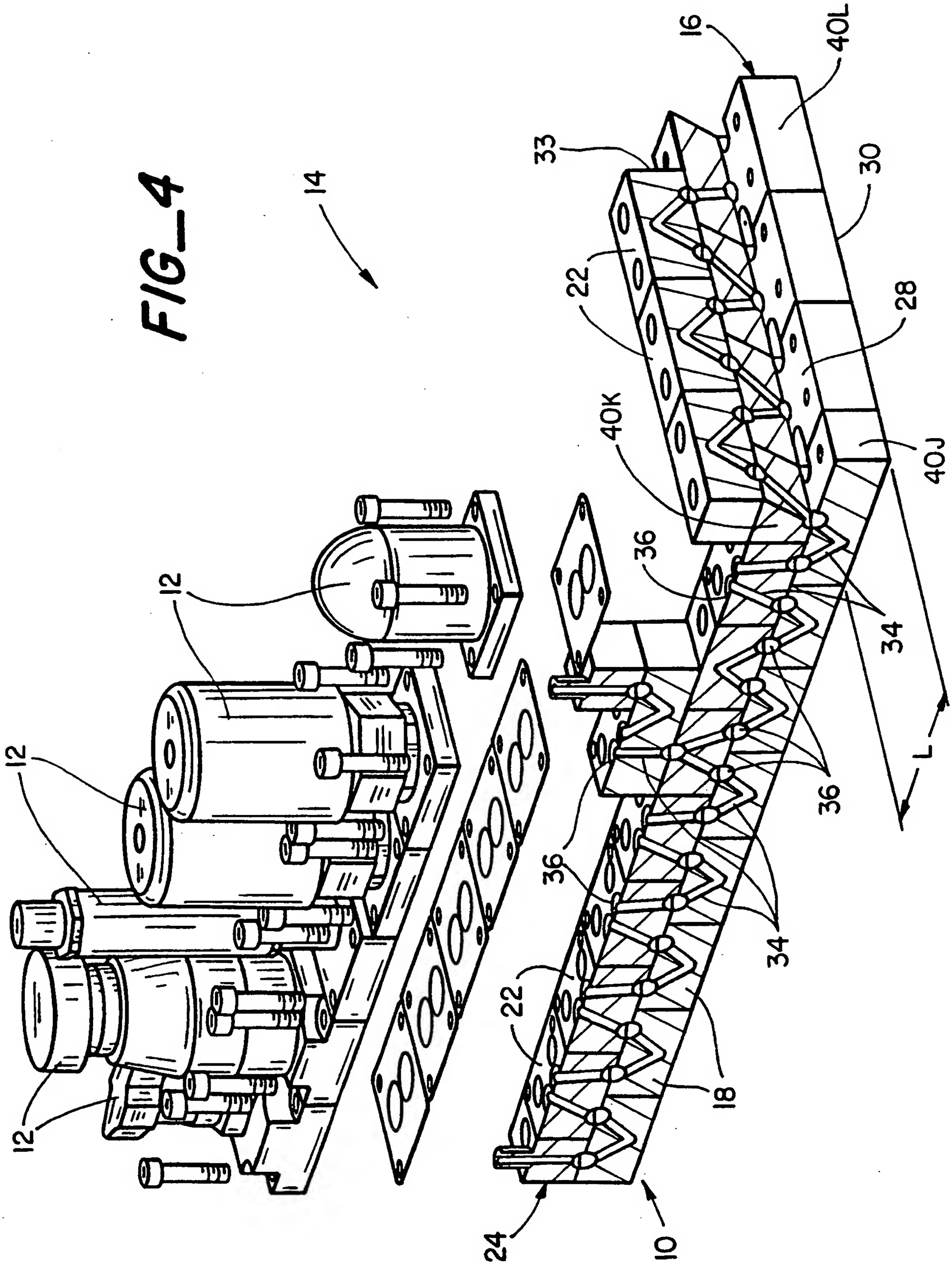


FIG_3

FIG_4



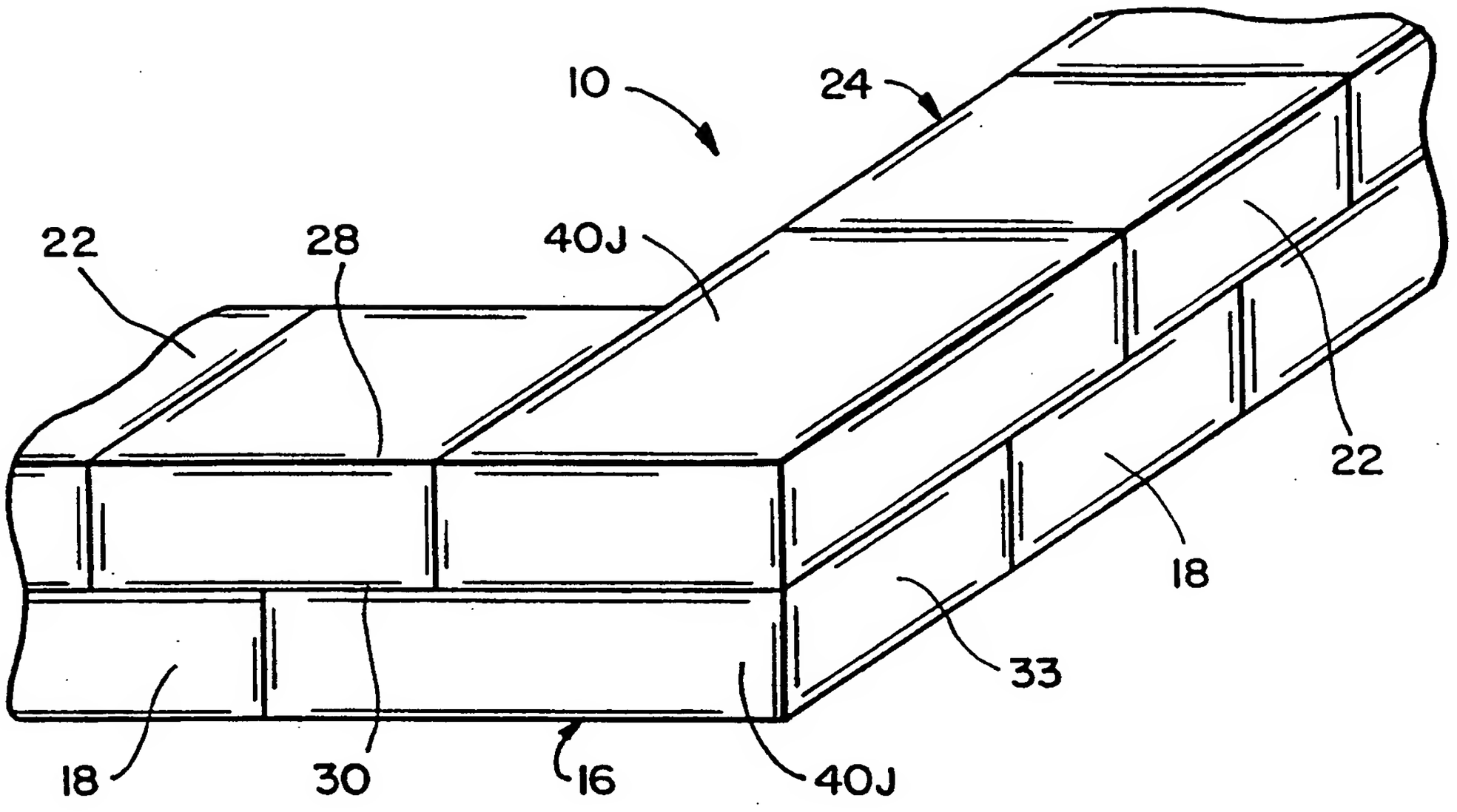


FIG_5A

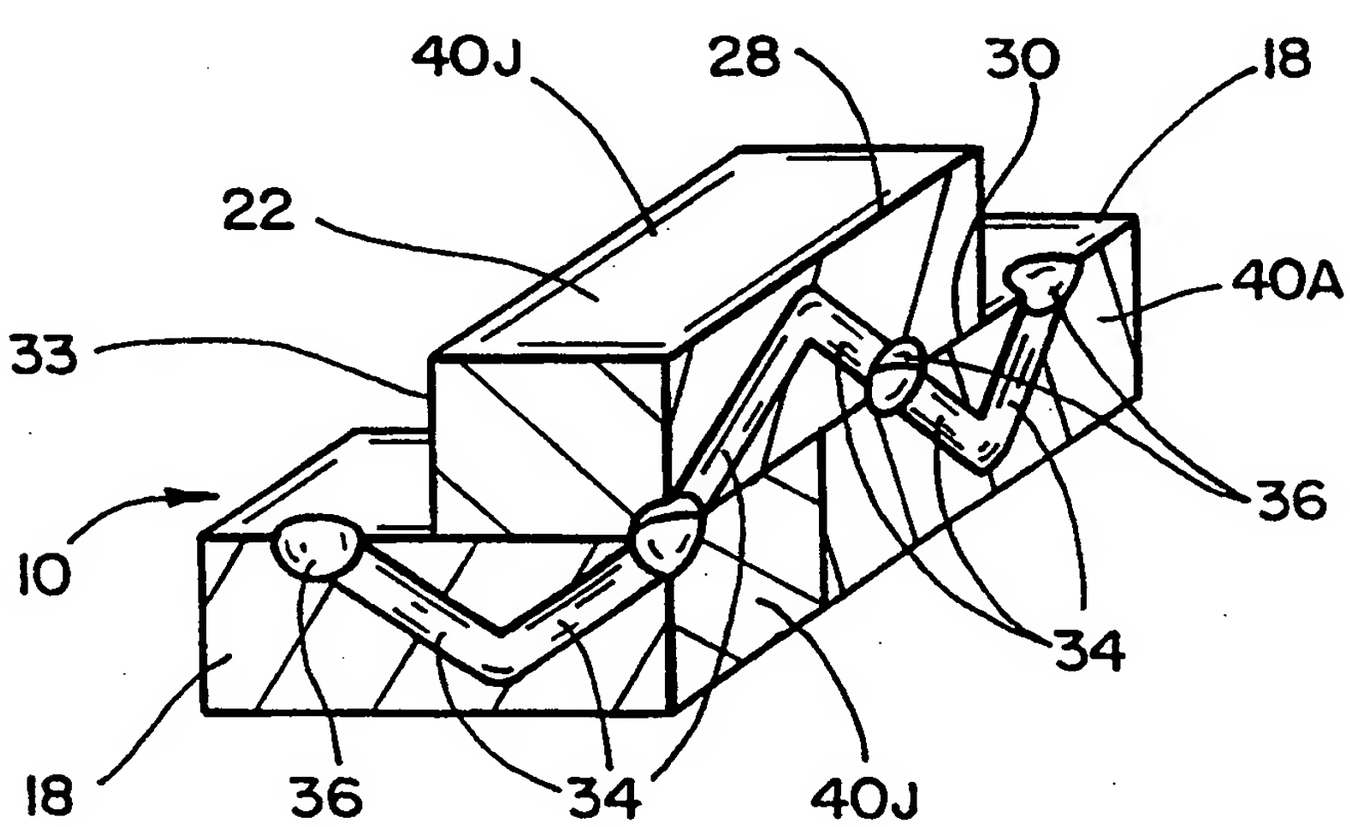


FIG_5B

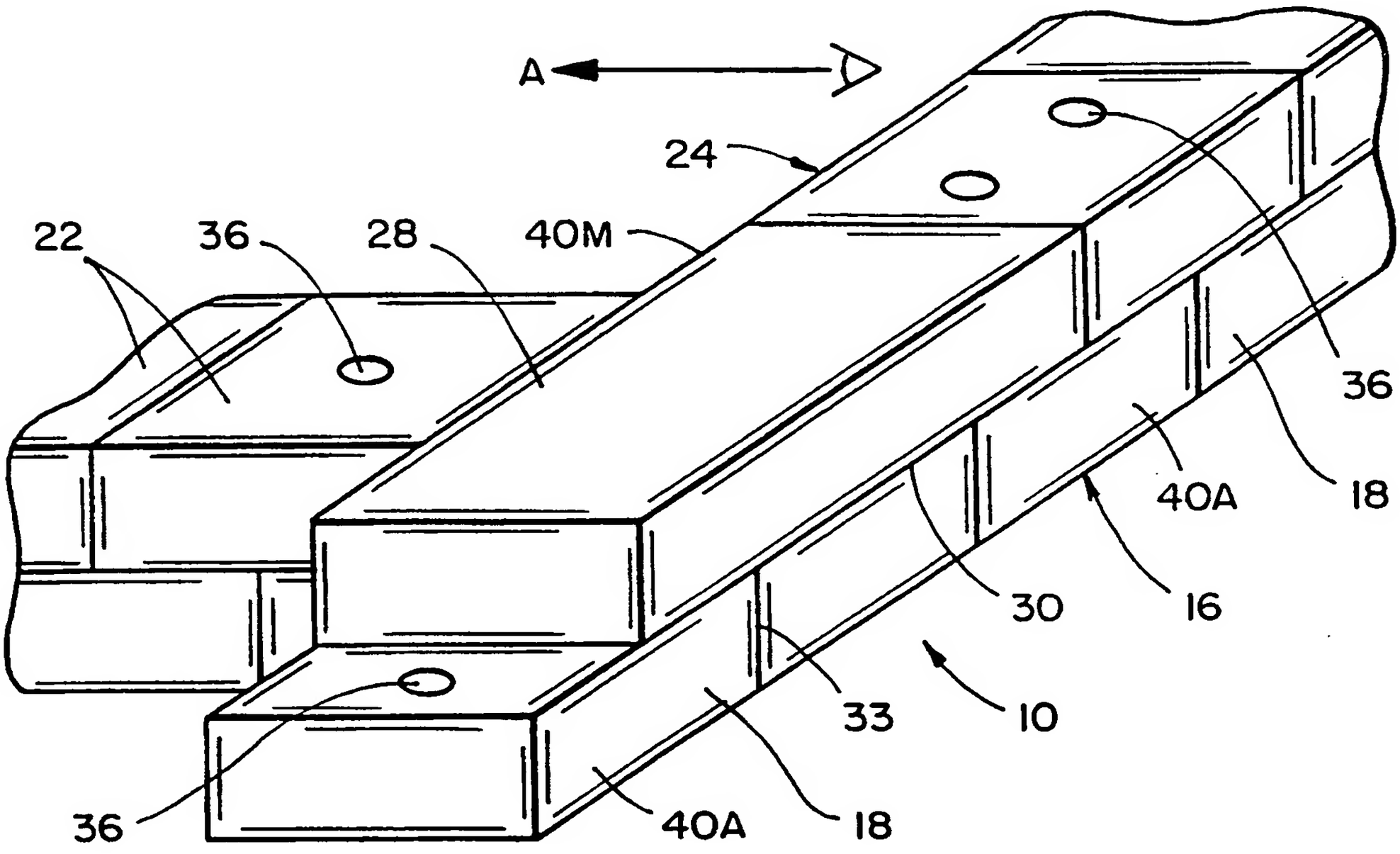


FIG_6A

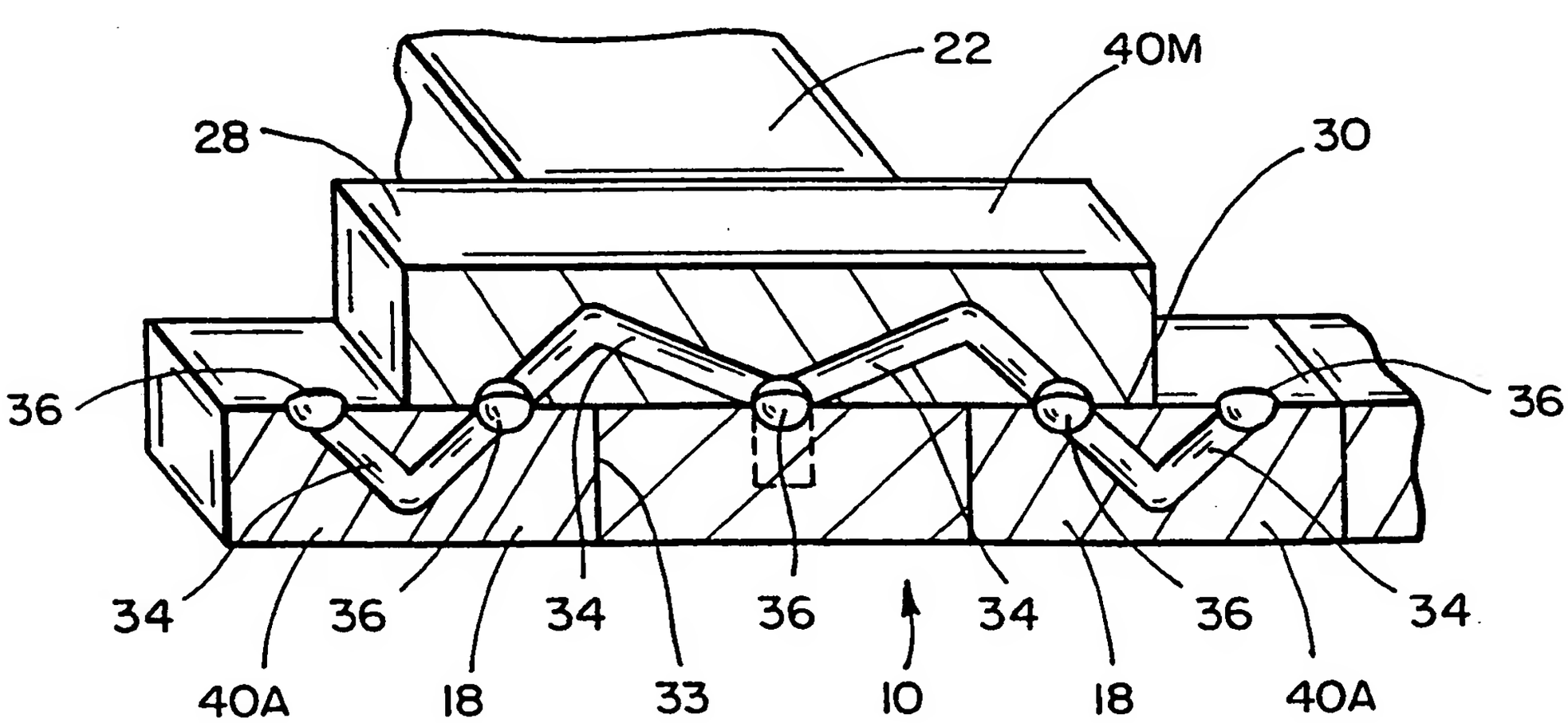


FIG_6B

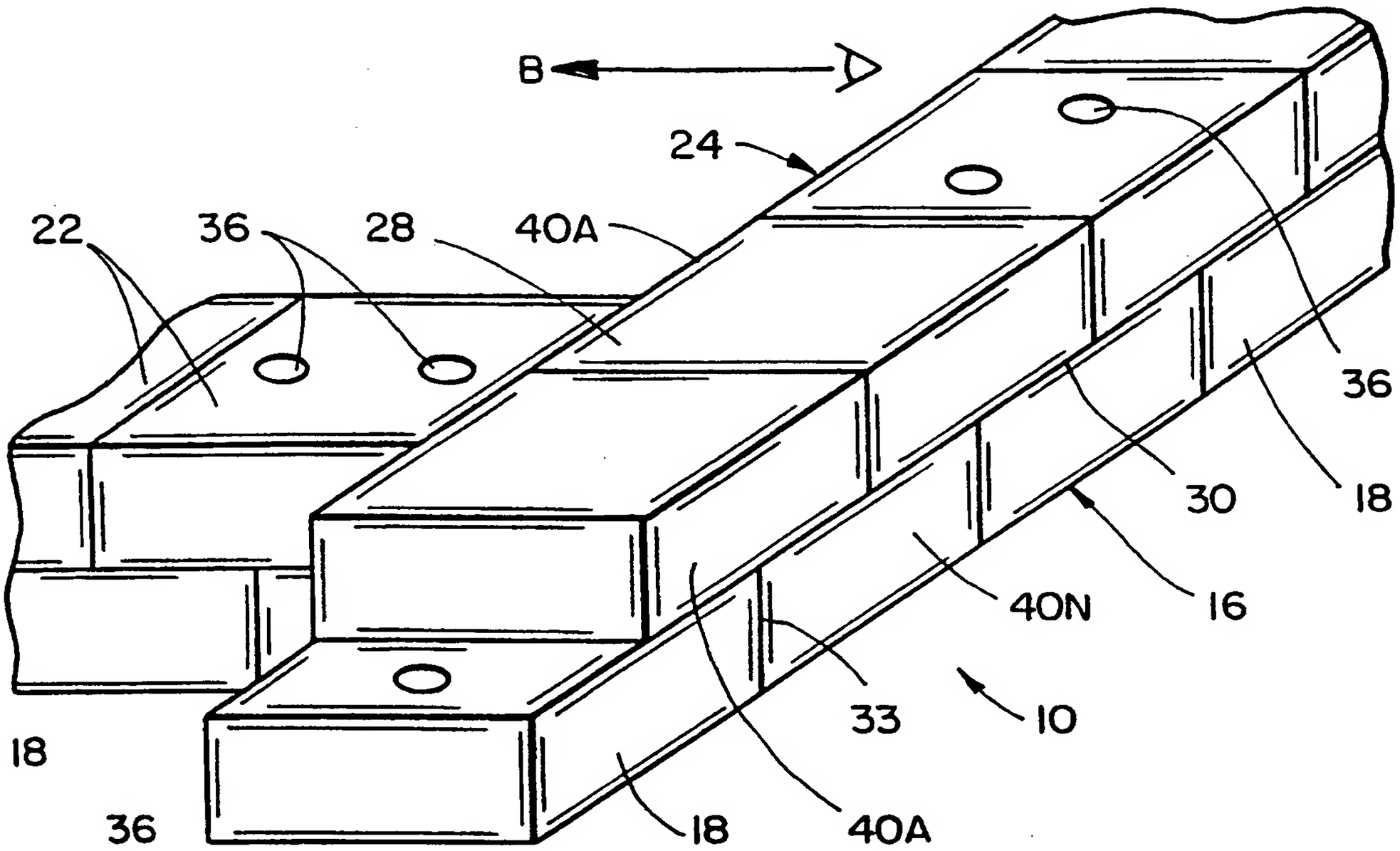


FIG_7B

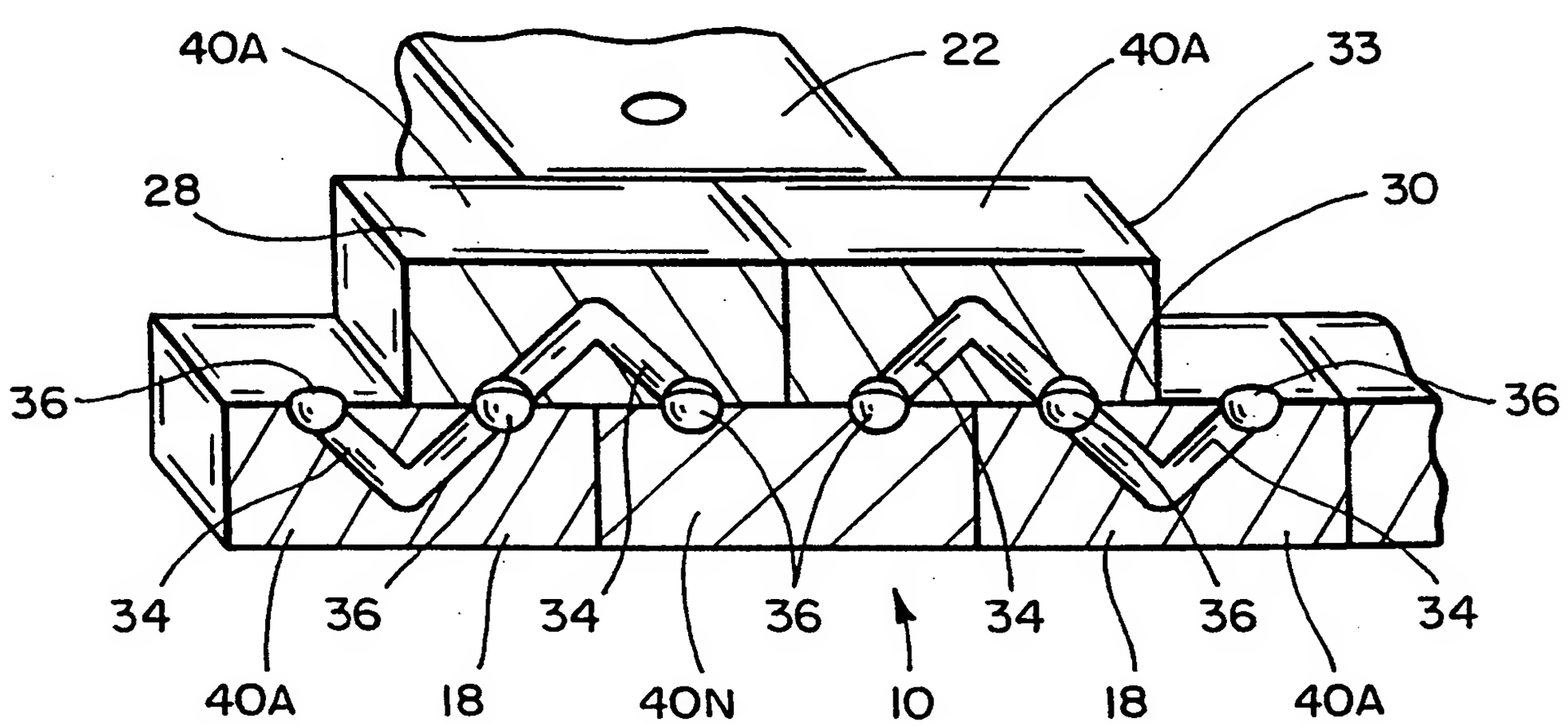


FIG_7C

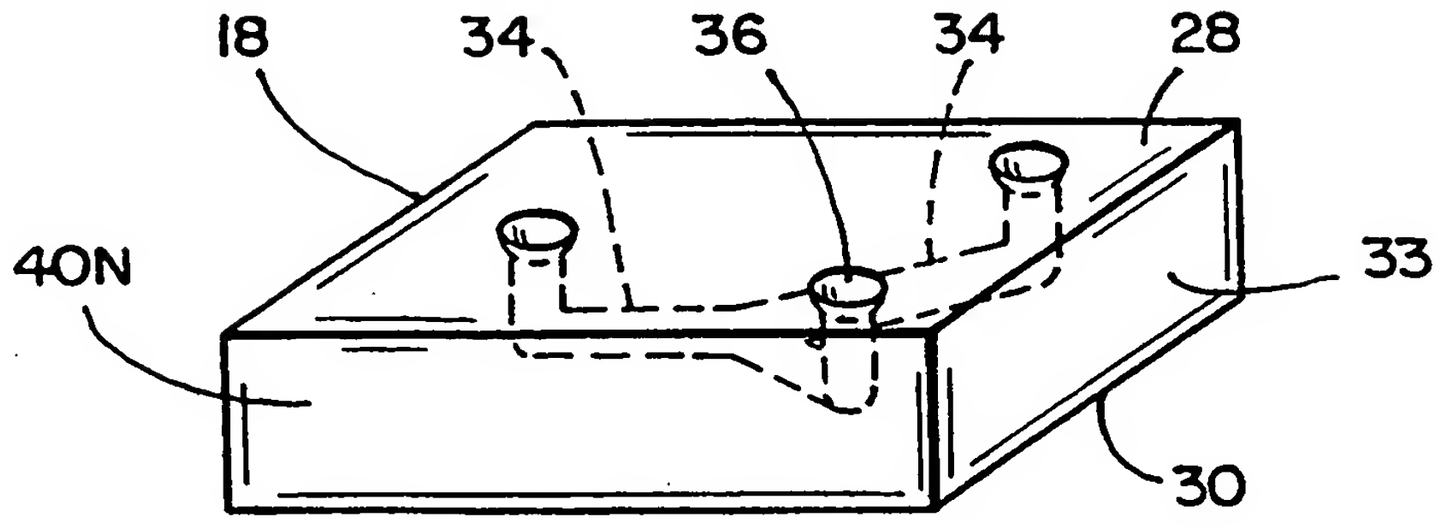


FIG_7A

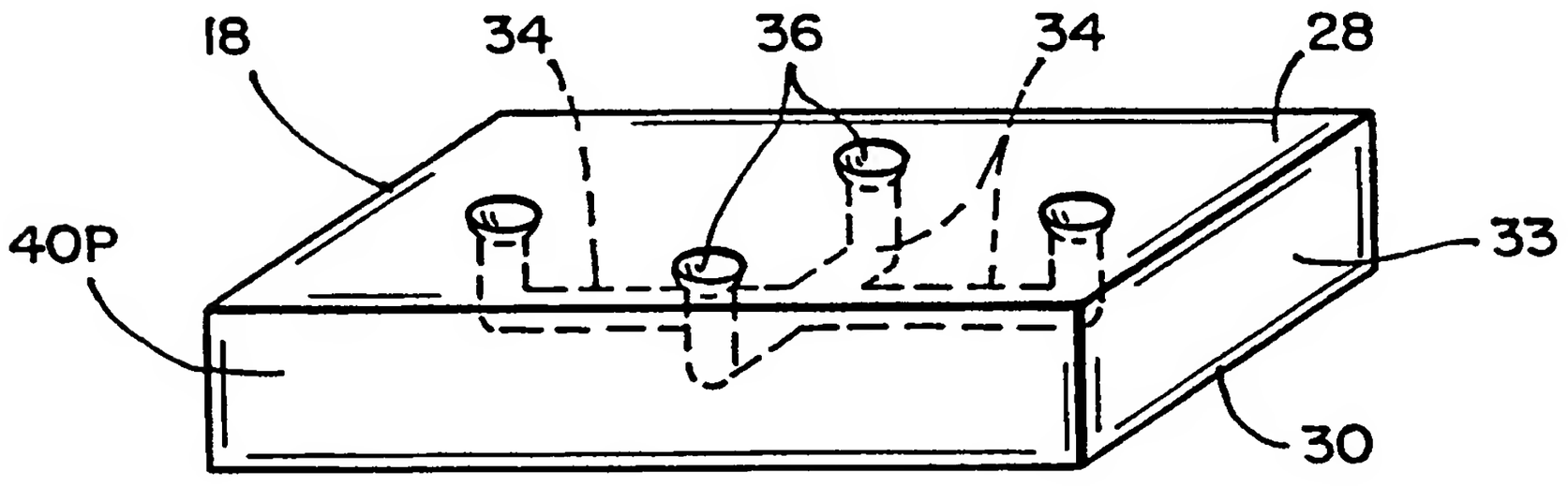


FIG_8

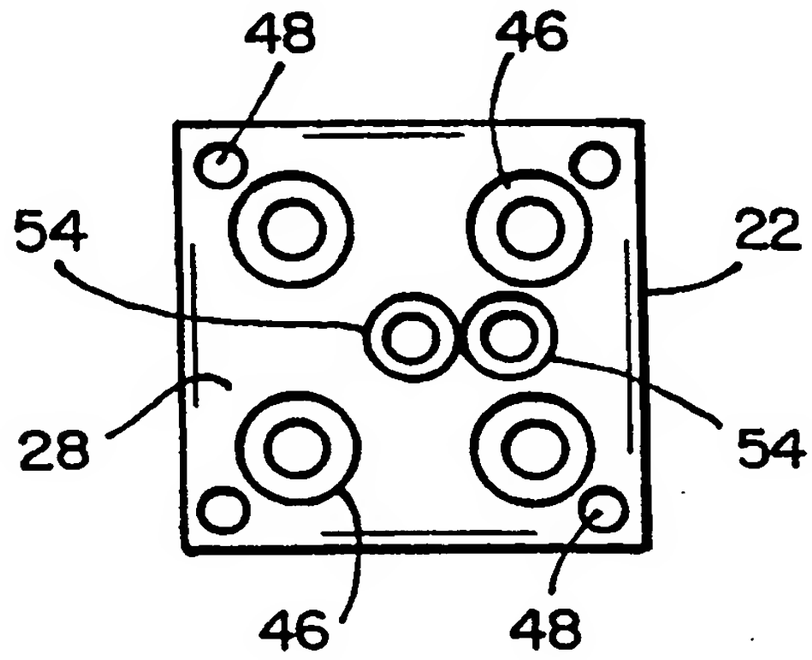


FIG_9B

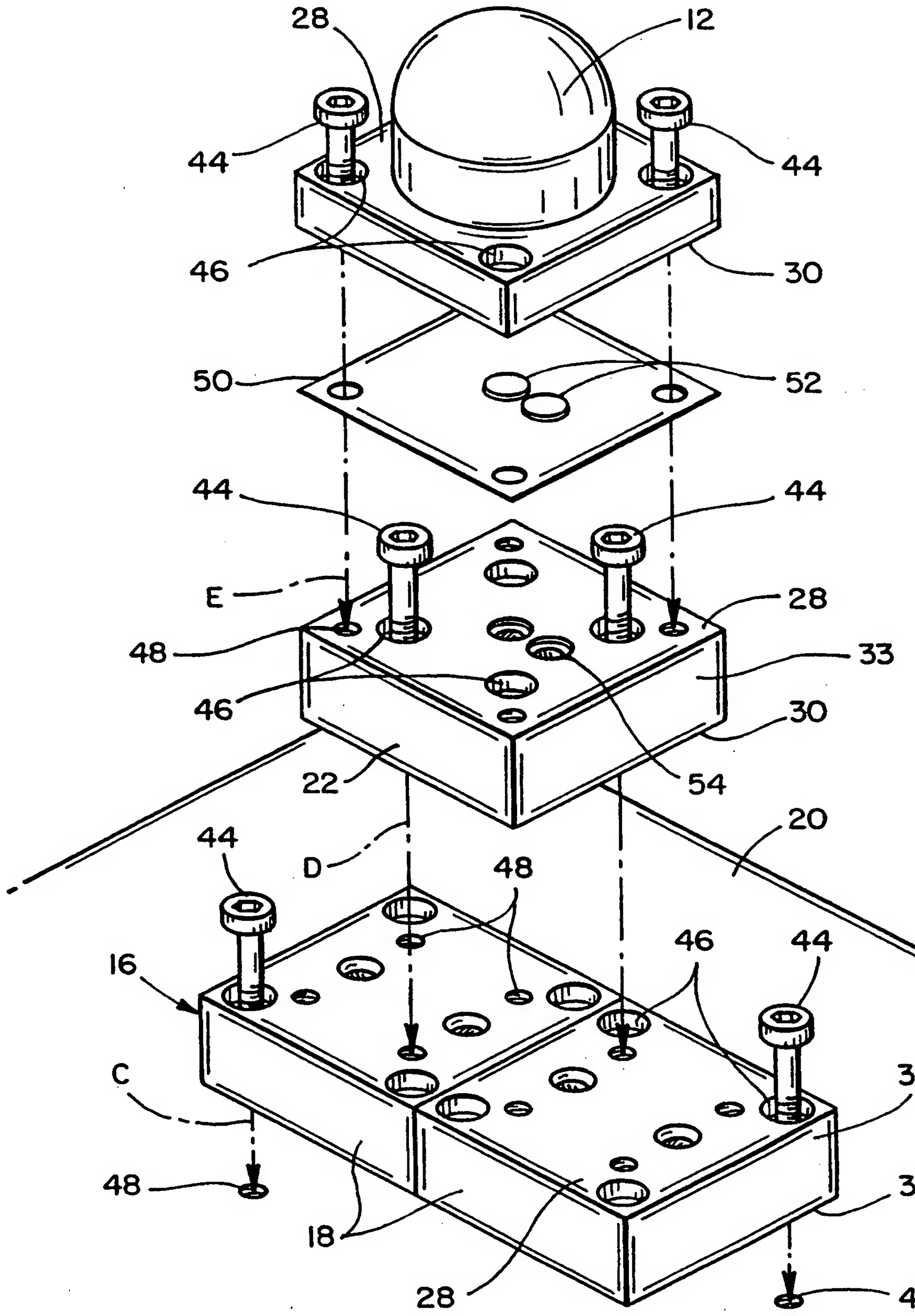


FIG_9A

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/21227

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) : F16K 11/20
US CL : 137/884, 613
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 137/269, 613, 884

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 845 623 A1 (OHMI) 18 November 1997 (18.11.1997), figure 1.	1-55

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 September 2000 (20.09.2000)	17 OCT 2000
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703)305-3230	Authorized officer John Fox Telephone No. 703-308-0975

Form PCT/ISA/210 (second sheet) (July 1998)